Understanding and Protecting our Home Planet:

NASA's Earth Science Enterprise

2002 Year in Review

Throughout the year, NASA's Earth Science Enterprise has been the leader in pushing the frontier of scientific understanding of our changing planet. In 2002, we made significant progress toward providing answers to the question: "How is the Earth changing and what are the consequences for life on Earth?"

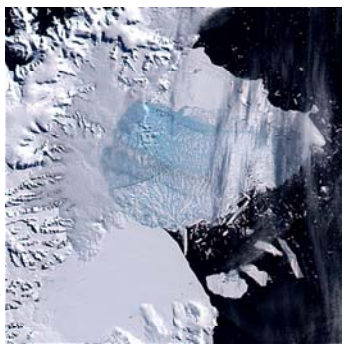
• We created and now operate a fleet of scientific instruments in space. This first-of-its-kind Earth Observing System is capable of monitoring long-term change in the Earth system.

• We enabled a myriad of down-to-Earth practical applications of space-based Earth observations in management of forest fires, floods, food and fiber protection.

• We partnered with industry and academia to develop breakthrough technologies to address national priorities.

• We inspired the next generation of explorers by sharing the excitement of discovery with our Nation's educators and students.

Disintegration of Antarctic Ice Shelf

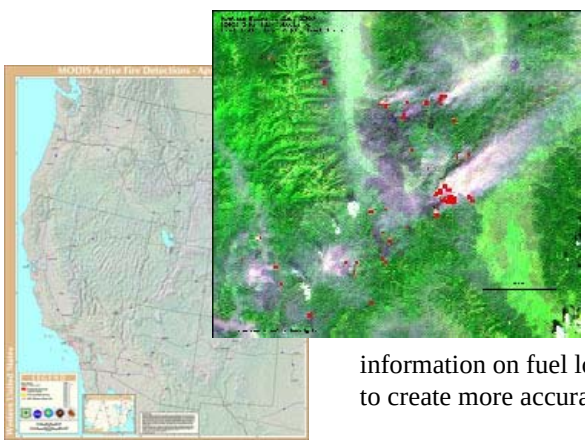


Understanding ice sheet calving is important both for understanding changes in Earth's ice caps and understanding ocean, ice and climate interactions. A NASA sponsored study found that glaciers melting following ice maxima or ice ages can dramatically affect global ocean currents and hence marine and terrestrial productivity. In the near term, changes in the distribution of icebergs were shown to dramatically affect the dynamics of the marine ecosystem food chain following large ice calving events.

Digital Elevation models of the Western Hemisphere

This joint NASA-Department of Defense mission used breakthrough technologies such as dual-radar interferometry to map 80 percent of the Earth's land surface in just 11 days via the Space Shuttle. Applications of the Shuttle Radar Topography Mission data to watershed management, flood remediation and

ecosystem management were showcased at the 2002 World Summit on Sustainable Development.



Rapid Fire Response with MODIS Sensors

For the second year in a row, wildfires coincident with widespread summer drought have challenged the resources of the U.S. Forest Service and other agencies responsible for the detection, assessment and remediation of forest fires. By providing near real-time data from the MODIS sensors on Terra and Aqua daily, the forest service was better able to mobilize resources to combat fires. These data coupled with information on fuel load, openness of forest canopy and topography are used to create more accurate models of probable fire tracks.

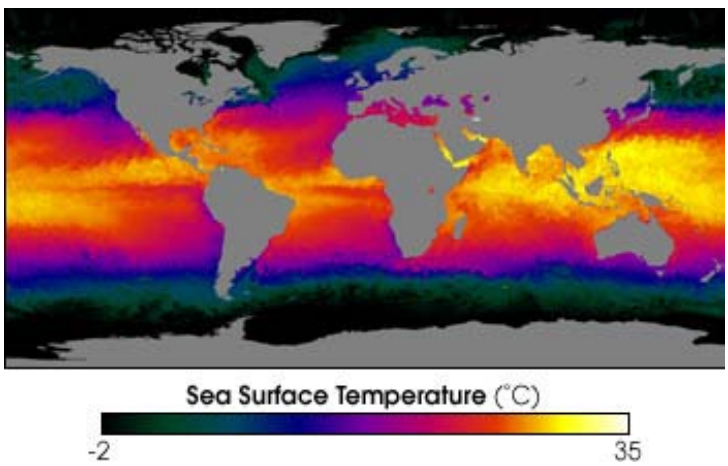
Improved Hurricane Prediction

CRYSTAL-FACE, or "Cirrus Regional Study of Tropical Anvils and Cirrus Layers - Florida Area Cirrus Experiment," included more than 400 researchers from around the world and six different research aircraft equipped with advanced scientific instruments for studying the clouds over and around Florida. NASA will use the data to enhance our understanding of how clouds insulate the Earth and reflect heat in our atmosphere. These measurements were combined with information from satellites to create better models of hurricane development and landfall tracks for decision support purposes.

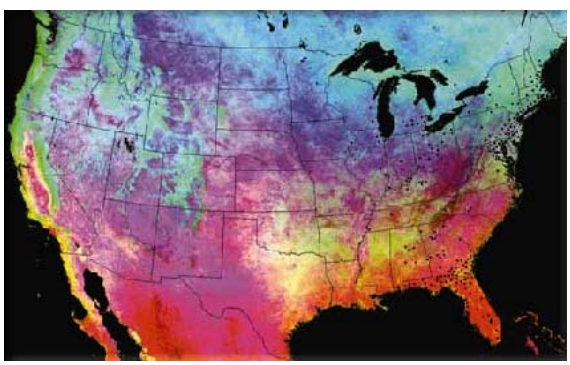
Earth's Equatorial Bulge Found to be Increasing

NASA satellite observations show that the bulge in the Earth's gravity field is increasing at the equator. This change in the Earth's profile is a departure from the long term trend of increasing roundness due to the slow recovery from the weight of the continental ice age glaciers. The gravitational change is not noticeable to most of us - the mass change was detected by precisely measuring changes in the orbits of satellites using laser ranging. Researchers believe this equatorial shift may be caused by a large-scale shift in ocean currents concentrating large masses of water at the equator which may be augmented by the accelerated melting of polar ice. NASA and its French and German space agency partners have recently launched the Jason-1, ICEsat and GRACE satellites which are designed to better track these changes in distribution of water on our planet.

Improved Seasonal Forecasting



Improving seasonal climate forecasts can help people and governments make informed decisions about a range of environmental issues, especially those related to agriculture, energy, and water resources. NASA's data and modeling efforts are making significant advances in this area. Observations of ocean surface topography are used as experimental input in seasonal climate models. Fully coupled atmosphere-ocean-land models provide regular input to national and international modeling efforts aimed at improving seasonal climate prediction and also serve as the basis for studies of regional impacts of climate variation, most notably that associated with flood and drought events in North America and the Asian/Australian monsoon regions.

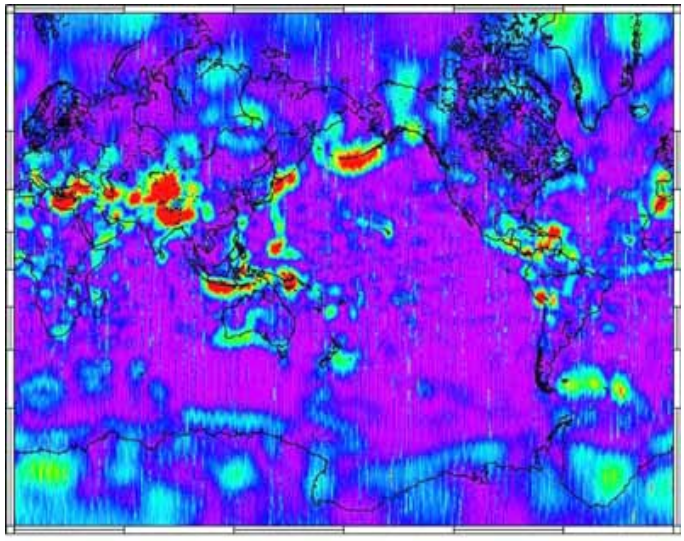


Satellite Observations Track Spread of West Nile Virus

NASA sponsored research will allow public health officials to better track and predict the spread of the West Nile Virus in the future. NASA's goal is to provide people on the front lines of public health with data and information resulting from its Earth Science Program to aid them in their work to combat the disease.

First Images from GRACE Reveal Most Accurate Map Yet of Earth's Gravity

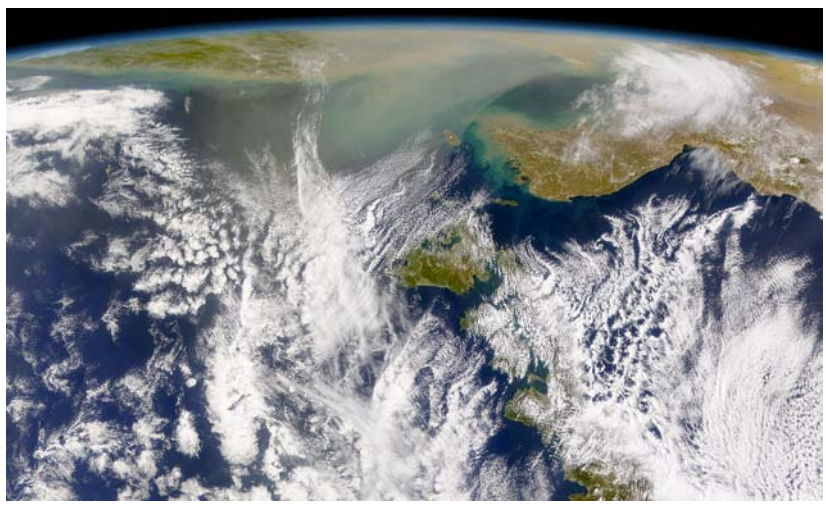
The first image released from the Gravity Recovery and Climate Experiment (GRACE) colorfully illustrates the sensitivity of the mission's twin spacecraft to variations in Earth's gravity field. Launched March 17, 2002, GRACE is able to detect and map extremely small variations in Earth's surface mass and corresponding variations in Earth's gravitational pull as they vary with time. The monthly gravity maps generated by GRACE will be up to 1000 times more accurate than current gravity maps, marking a major improvement in the accuracy of many techniques used by oceanographers, hydrologists, glaciologists, geologists and other scientists to study phenomena that influence Earth's climate. GRACE is a joint partnership between NASA and the German Aerospace Center Deutsches Zentrum fuer Luft und Raumfahrt, or DLR.



Gravity Field Sensed by GRACE in Microns

Detecting Aerosol in our Atmosphere

Before scientists can assess the effect of aerosols on climate, they first need to distinguish natural from human-made aerosols. Satellite data and modeling of aerosol transport enabled distinction between smoke and regional pollution based on the size of the different particles. Increases in the amount of aerosol and changes in their composition caused by industrialization and an expanding population may be harmful to the Earth's climate and human health.

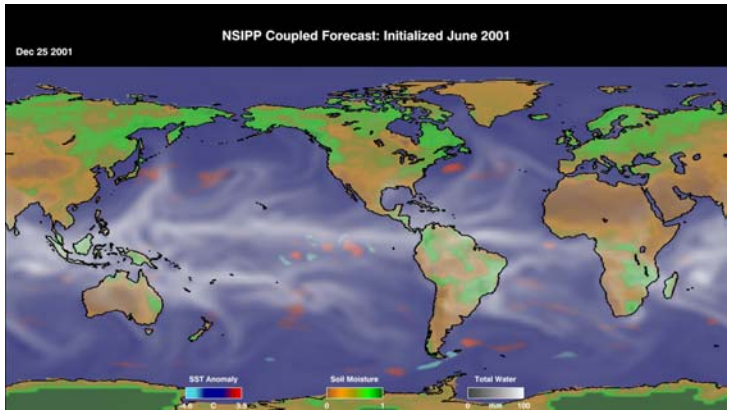


NASA Navigation Work Yields Science, Civil, Commerce Benefits

NASA researchers have demonstrated the ability of NASA's Global Differential GPS system to achieve real-time aircraft positioning accuracy of 10 cm (3.9 in.) horizontally and 20 cm (7.9 in.) vertically, anywhere in the world - a factor of 10 improvement over current autonomous navigation systems. Although developed to improve the accuracy, efficiency and timeliness of Earth science satellite data, the breakthrough will extend precision navigation to infrastructure-poor areas of the

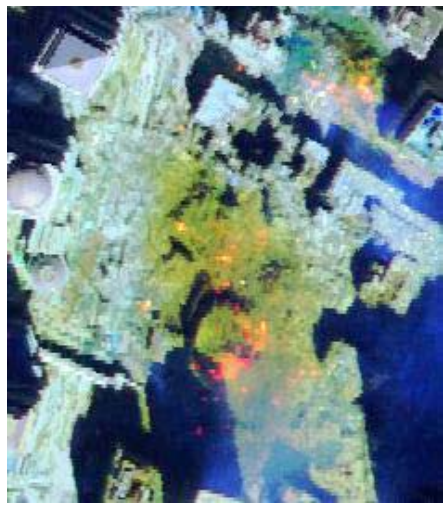
world, potentially enhancing aviation safety in these areas.

Earth Observing Satellites Provide Key Variable in Understanding Land Climate Interactions



The first meaningful estimates of soil moisture from space were retrieved as the Advanced Microwave Scanning Radiometer (AMSR), onboard the Aqua spacecraft, began transmitting data to Earth on June 1, 2002. Soil moisture controls the proportion of rainfall that runs off or evaporates from land, and it enables photosynthesis in plants that use solar energy to convert carbon dioxide and water into the oxygen and food necessary for life on Earth. This moisture is also important for maintaining crop and vegetation health. Measuring soil moisture on a global basis will allow drought-prone areas to be effectively monitored. The AMSR-E is a cooperative effort between NASA and the National Space Development Agency (NASDA) of Japan.

Hidden Hot Spots Revealed at World Trade Center Disaster Site



Firefighters were able to reduce the temperature of dangerous "hot spots" at the site of the World Trade Center based on specialized maps and analysis of surface temperature from NASA sensors. Working alongside several federal agencies, NASA was able to apply its advanced remote sensing capabilities to aid in the disaster relief efforts in the days immediately following September 11, 2001. NASA's Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) was flown by its JPL team over the Trade Center on September 16, 18, 22, and 23 to create these maps.

We have liftoff!

The Aqua satellite, a joint project between the United States, Japan, and Brazil, was successfully carried into orbit from Vandenberg Air Force Base on May 4, 2002. Dedicated to advancing our understanding of Earth's water cycle and environment, the Aqua spacecraft will collect data on global precipitation, evaporation, and the cycling of water. The twin satellites of the GRACE (Gravity Recovery And Climate Experiment) mission were successfully launched from Plesetsk, Russia, on March 17, 2002. The joint mission between NASA and the German Aerospace Center, Deutsches Zentrum fuer Luft und Raumfahrt (DLR), will model the Earth's gravity field with unprecedented accuracy. NASA supported the development and successful launch of NOAA-17, an environmental satellite that will improve weather forecasting and monitor environmental events around the world. This is the third in a series of five polar-orbiting satellites with improved imaging and sounding capabilities that will operate over the next 10 years. NOAA-17 will collect meteorological data and transmit the information to users around the world to enhance weather forecasting. In the United States, the data will be used for long-range weather and climate forecasts.